That which is claimed is:

1. A process for the production of refinery transportation fuel or blending components for refinery transportation fuel, which process comprises:

providing organic feedstock comprising a mixture of organic compounds derived from natural petroleum, the mixture having a gravity ranging from about 10° API to about 100° API;

contacting a gaseous source of dioxygen with the organic feedstock in a liquid reaction medium containing a soluble catalyst system comprising at least one multi-valent and/or heavy metal while maintaining the liquid reaction medium substantially free of halogen and/or halogen-containing compounds, to form a mixture of immiscible phases comprising hydrocarbons, oxygenated organic compounds, water of reaction, and acidic co-products; and

separating from the mixture of immiscible phases at least a first organic liquid of low density comprising hydrocarbons, oxygenated organic compounds and acidic co-products, and second liquid of high density which contains at least portions of the catalyst metal, water of reaction and acidic co-products.

2. The process according to claim 1 wherein the organic feedstock comprises sulfur-containing and/or nitrogen-containing organic compounds one or more of which are oxidized in the liquid reaction medium, and wherein the second separated liquid is an aqueous solution containing at least a portion of the oxidized sulfur-containing and/or nitrogen-containing organic compounds.

3. The process according to claim 2 which further comprises contacting the separated organic liquid with a neutralizing agent and recovering a product having a low content of acidic co-products.

4. The process according to claim 1 wherein the catalyst metal is selected from the group consisting of manganese, cobalt, nickel, chromium, vanadium, molybdenum, tungsten, tin, cerium, or mixture thereof, and which further comprises recovering at least a portion of the catalyst system from the separated second liquid; and

injecting all or a portion of the recovered catalyst system into the liquid reaction medium.

5. The process according to claim 1 wherein all or at least a portion of the organic feedstock is a product of a hydrotreating process for petroleum distillates consisting essentially of material boiling between about 50° C. and about 425° C. which hydrotreating process includes reacting the petroleum distillate with a source of hydrogen at hydrogenation conditions in the presence of a hydrogenation catalyst to assist by hydrogenation removal of sulfur and/or nitrogen from the hydrotreated petroleum distillate.

6. The process according to claim 5 wherein the hydrogenation catalyst comprises at least one active metal, selected from the group consisting of the *d*-transition elements in the Periodic Table, each incorporated onto an inert support in an amount of from about 0.1 percent to about 20 percent by weight of the total catalyst.

7. The process according to claim 5 wherein the hydrotreating process further comprises partitioning of the hydrotreated petroleum distillate by distillation to provide at least one low-boiling liquid consisting of a sulfur-lean, mono-aromatic-rich fraction, and a high-boiling liquid consisting of a sulfur-rich, mono-aromatic-lean fraction, and wherein the organic feedstock is predominantly the low-boiling liquid.

8. The process according to claim 1 wherein the catalyst system comprises a source of catalyst metal selected from the group consisting of manganese, cobalt, nickel, chromium, vanadium, molybdenum, tungsten, tin, cerium, or mixture thereof, in the form of a salt of an organic acid having up to about 8 carbon atoms

9. The process according to claim 1 wherein the catalyst system comprises a source of catalyst metal selected from the group consisting of compounds represented by formula

$$M[RCOCH{=}C(O\text{-})R']_x$$

where M is one or more member of the group consisting of manganese, cobalt, nickel, chromium, vanadium, molybdenum, tungsten, tin and cerium, R and R' are the same or different members of the group consisting of a hydrogen atom and methyl, alkyl, aryl, alkenyl and alkynyl groups having up to about 20 carbon atoms, and x is 2 or 3.

10. The process according to claim 1 wherein the catalyst system comprises a source of catalyst metal selected from the group consisting of compounds represented by formula

$$Mn[RCOCH=C(O-)R']_2 ,$$

$$Co[RCOCH=C(O-)R']_2 \quad \text{and/or}$$

$$Ce[RCOCH=C(O-)R']_3$$

where R and R' are the same or different members of the group consisting of a hydrogen atom and methyl, alkyl, aryl, alkenyl and alkynyl groups having up to about 20 carbon atoms.

11. A process for the production of refinery transportation fuel or blending components for refinery transportation fuel, which process comprises:

partitioning by distillation an organic feedstock comprising a mixture of organic compounds derived from natural petroleum, the mixture having a gravity ranging from about 10° API to about 100° API to provide at least one low-boiling organic part consisting of a sulfur-lean, mono-aromatic-rich fraction, and a high-boiling organic part consisting of a sulfur-rich, mono-aromatic-lean fraction;

contacting a gaseous source of dioxygen with at least a portion of the low-boiling organic part in a liquid reaction medium containing a soluble catalyst system comprising a source of at least one catalyst metal selected from the group consisting of manganese, cobalt, nickel, chromium, vanadium, molybdenum, tungsten, tin, cerium, or mixture thereof, while maintaining the liquid reaction medium substantially free of halogen and/or halogen-containing compounds, to form a mixture of immiscible phases comprising

hydrocarbons, oxygenated organic compounds, water of reaction, and acidic co-products;

separating from the mixture of immiscible phases at least a first organic liquid of low density comprising hydrocarbons, oxygenated organic compounds and acidic co-products and second liquid of high density which contains at least portions of the catalyst metal, water of reaction and acidic co-products; and

contacting all or a portion of the separated organic liquid with a neutralizing agent thereby recovering a low-boiling oxygenated product having a low content of acidic co-products.

12. The process according to claim 11 wherein at least a portion of the separated organic liquid is contacted with an aqueous solution of a chemical base, and the recovered oxygenated product exhibits a total acid number of less than about 20 mg KOH/g.

13. The process according to claim 12 wherein the chemical base is a compound selected from the group consisting of sodium, potassium, barium, calcium and magnesium in the form of hydroxide, carbonate or bicarbonate.

14. The process according to claim 11 wherein all or at least a potion of the organic feedstock is a product of a process for hydrogenation of a petroleum distillate consisting essentially of material boiling between about 50° C. and about 425° C. which hydrogenation process includes reacting the petroleum distillate with a source of hydrogen at hydrogenation conditions in the presence of a hydrogenation catalyst to assist by hydrogenation removal of sulfur and/or nitrogen from the hydrotreated petroleum distillate.

15. A process for the production of refinery transportation fuel or blending components for refinery transportation fuel, which process comprises:

partitioning by distillation an organic feedstock comprising a mixture of organic compounds derived from natural petroleum, the mixture consisting essentially of material boiling between about 75° C. and about 425° C. to provide at least one low-boiling organic part consisting of a sulfur-lean, mono-aromatic-rich fraction, and a high-

boiling organic part consisting of a sulfur-rich, mono-aromatic-lean fraction;

contacting a gaseous source of dioxygen with at least a portion of the low-boiling organic part in a liquid reaction medium containing a soluble catalyst system comprising a source of at least one catalyst metal selected from the group consisting of manganese, cobalt, nickel, chromium, vanadium, molybdenum, tungsten, tin, cerium, or mixture thereof, while maintaining the liquid reaction medium substantially free of halogen and/or halogen-containing compounds, to form a mixture of immiscible phases comprising hydrocarbons, oxygenated organic compounds, water of reaction, and acidic co-products;

separating from the mixture of immiscible phases at least a first organic liquid of low density comprising hydrocarbons, oxygenated organic compounds and acidic co-products and second liquid of high density which contains at least portions of the catalyst metal, water of reaction and acidic co-products; and

contacting all or a portion of the separated organic liquid with a neutralizing agent and recovering a low-boiling oxygenated product having a low content of acidic co-products; and

contacting the high-boiling organic part with an immiscible phase comprising at least one organic peracid or precursors of organic peracid in a liquid reaction mixture maintained substantially free of catalytic active metals and/or active metal-containing compounds and under conditions suitable for oxidation of one or more of the sulfur-containing and/or nitrogen-containing organic compounds;

separating at least a portion of the immiscible peracid-containing phase from the oxidized phase of the reaction mixture; and

contacting the oxidized phase of the reaction mixture with a solid sorbent, an ion exchange resin, and/or a suitable immiscible liquid containing a solvent or a soluble basic chemical compound, to obtain a high-boiling product containing less sulfur and/or less nitrogen than the high-boiling fraction.

16. The process according to claim 15 wherein the immiscible phase is formed by admixing a source of hydrogen

peroxide and/or alkylhydroperoxide, an aliphatic monocarboxylic acid of 2 to about 6 carbon atoms, and water.

17. The process according to claim 15 wherein the immiscible phase is formed by admixing hydrogen peroxide, acetic acid, and water.

18. The process according to claim 15 wherein at least a portion of the separated peracid-containing phase is recycled to the reaction mixture.

19. The process according to claim 15 further comprising blending at least a portion of the low-boiling oxygenated product with at least a portion of the high-boiling product to obtain components for refinery blending of transportation fuel.

20. The process according to claim 15 wherein the oxidation feedstock is a high-boiling distillate fraction consists essentially of material boiling between about 200° C. and about 425° C derived from hydrotreating of a refinery stream.